
Space Weather Technical Forecast

Issued on Sunday, 05 November 2023 at 13:34 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: G1/G2 Minor/Moderate geomagnetic storms expected and chance of G3/Strong storming day 1-2 (05-06 Nov) due to CME arrival. Chance of M-Class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with a M1.8 flare observed from AR3480 at 05/1145 UTC. This is the only significant flare from the last 24 hours, with much of the activity at Low, C-class levels. AR3480 is the most complex region on the visible disc with a Beta-Gamma magnetic arrangement. AR3479 is the largest region but appears relatively stable, with a beta magnetic configuration. AR3472 and AR3474 on the northwest and southwest limb respectively, appear to be exhibiting bright flux regions, but are now difficult to analyse. Nonetheless, these regions contain an ongoing risk of M-class flaring. Of the total eight regions, the remaining regions are all relatively simple. Two new CMEs have been observed leaving the Sun in the last 24 hours, one to the east and one to the southwest. Initial analysis of satellite imagery suggests that these will miss the Earth, but a more detailed analysis will be conducted once sufficient imagery is available.

Solar Wind / Geomagnetic Activity: Solar winds at L1, have exhibited signatures of three CMEs in the last 24 hours. The first was likely to be as a result of an eruption on 31 Oct and as a glancing blow. From initial background this led to an increase in speeds to around 350km/s, before declining to background, the second CME resulted in an increase to 420 km/s at 05/0813 UTC and after a modest decline in speeds to 400 km/s the third CME resulted in an increase to 503 km/s at 05/1204 UTC on a rising trend. Density started above average, reaching a peak of 53ppcc at 04/1643 UTC due to the glancing CME. After a decline to average values, the second and third CME achieved densities of 36 ppcc at 05/0836 UTC and 53 ppcc at 05/1147 UTC. Total interplanetary magnetic field strength (IMF), Bt rose quickly from weak to strong levels by 04/1745 UTC. This returned to Moderate levels for a time, but then reached a very strong peak of 34 nT at 05/0838 UTC and then 45 nT at 05/1151 UTC as the two subsequent CMEs reached L1. The north south-component, Bz, was predominantly moderately negative until 04/2200 UTC and the predominantly moderately positive until 05/0814 UTC. There was then a very strong negative peak of -24 nT at 05/0905 nT and subsequent rotation to a strong positive direction, reaching a very strong positive peak of +44 nT at 05/1151 UTC. Phi angle started positive towards the Sun, but then slowly rotated to a negative direction from around 04/1600 UTC. The direction has been indeterminate since 05/0931 UTC. Geomagnetic activity rose from Quiet to Unsettled at the start of the period, to reach G1/Minor Storm between 04/1500-2100 UTC. A decline through Active in the following period was followed by a Quiet to Unsettled period until 05/0600-0900 UTC. A further G1/Minor Storm interval was observed at 05/0900-1200 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux eased from very slightly above base line due to the filament eruption on 03 Nov, to be at background. GOES16 high energy (greater than 2MeV) electron flux was predominately High for much of 04 Nov, and increased to peak 9840 pfu at 04/1700 UTC. A sudden drop-out followed, falling to background by 04/1905 UTC. The associated 24-hour fluence has been above the Active (1e8 integrated pfu) threshold throughout, but with a declining trend since the drop out. The fluence observation at 05/0000 UTC was 1.65e8 integrated pfu.

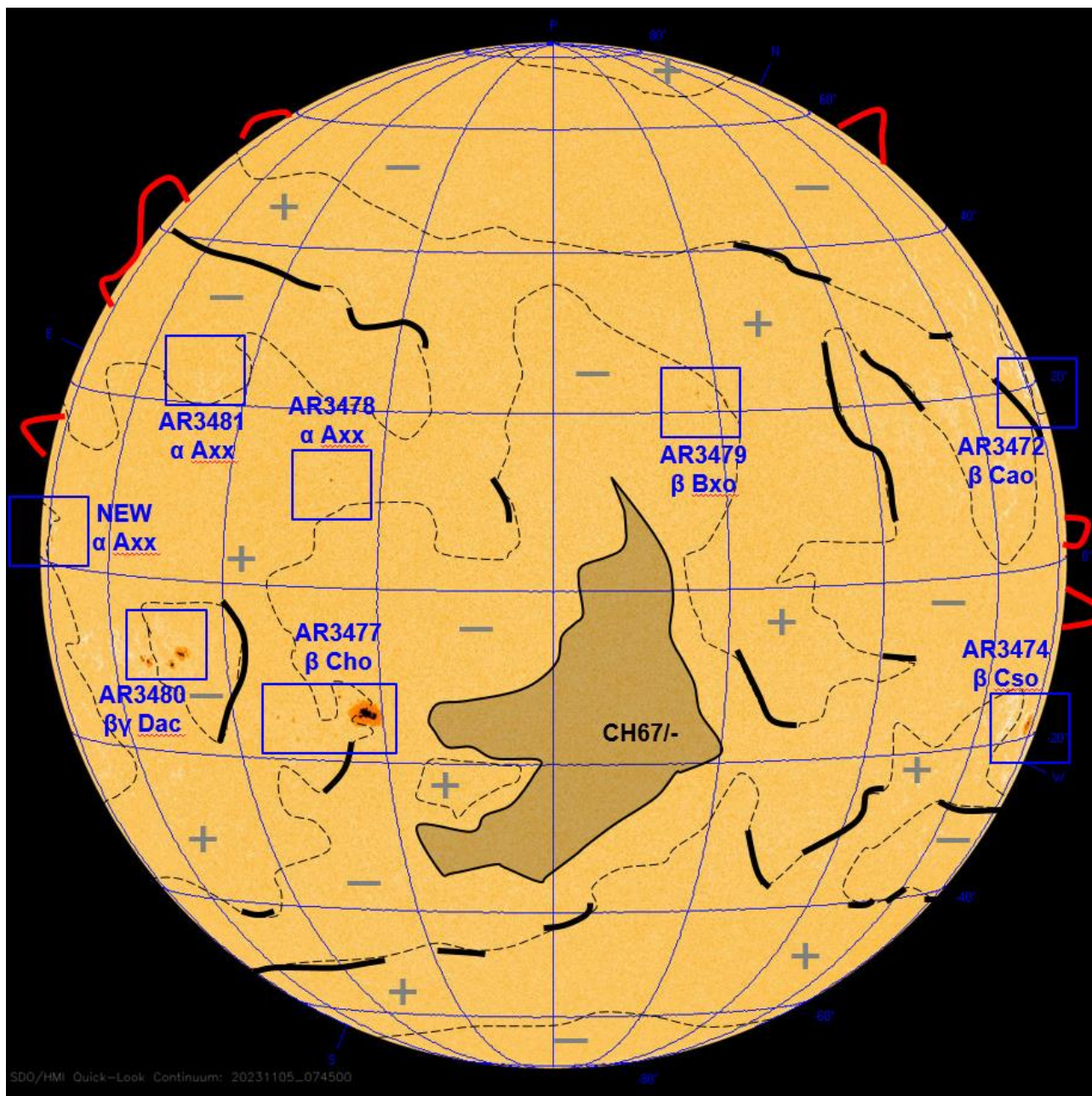
Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is expected, with chance of isolated M-class flares mainly from AR3480 in the southeast quadrant.

Solar Wind / Geomagnetic Activity: Three CMEs have arrived in the last 24 hours, with no further arrivals forecast. Speeds are around 500 km/s and may increase to around 600 km/s due to the evolving effects of the current CME. Speeds may then gradually decline before the forecast onset of the high speed stream from coronal hole 67, most likely on 07 Nov. Geomagnetic activity is forecast to be around G1/Minor Storm or G2/Moderate Storm on 05 Nov and perhaps into 06 Nov due to the recent CME arrivals, with a chance of G3/Strong Storms. Activity is then forecast to gradually wane through 06 Nov prior to the connection to the high speed stream, probably on 07 Nov when further G1/Minor Storm intervals are possible.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels. High energy electron flux (greater than 2MeV) is expected to remain mostly at background day 05 Nov-06 Nov. Some recovery is then likely, perhaps to High, however this is low confidence due to uncertainty with the impact of the CMEs and also the potential fast wind enhancements on 07 and 08 Nov. The associated 24 hour fluence is expected to soon fall below the Active threshold, and likely persist at this level. There is then a slight chance of rising above later in the period.

Figure 1. Solar Analysis Valid 05/0800 UTC.



Key: Filament ___, Prominence ___, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There were three CME arrivals in the last 24 hours, the first a glancing blow from a filament eruption from the southeast on 31 Oct and then from a CME which left the northeast of the disc 02/0230 UTC. The third arrival was from an eruption at 02/0430 UTC.

This last arrival is the fastest of the three CMEs due to arrive at Earth and as a large, dense filament this is expected to have the greatest effect of the three. In addition this follows two CMEs which could have cleared material from the near Earth environment, allowing it to approach Earth without as much resistance as the two previous features.

Solar wind speeds are currently at elevated speeds, around 500 km/s due to the CME arrivals. These are likely to then ease through the 05 Nov, but speeds could become enhanced to around 600 km/s. These speeds should then gradually decline during 06 and 07 Nov, prior to the arrival of the high speed stream from coronal hole 67 during 07 Nov, based on speeds of 600 km/s, although these are an estimate with no persistence or observations to rely on. Elevated speeds would then be likely to persist into 08 Nov.

Geomagnetic activity is forecast to be around G1/Minor storm or G2/Moderate Storm due to the recent CME arrivals. This risk is expected to continue through the remainder of the day. Due to the nature of the CME arrival, there is a chance of G3/Strong Storms. Activity is then likely to ease later 06 Nov and into 07 Nov, but this may be then enhanced due to the onset of the high speed stream from coronal hole 67, possibly giving further G1/Minor Storm intervals.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	80	70	20	10
Strong	G3	No	30	30	1	1
Severe	G4	No	5	5	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Observations of solar wind parameters at L1.



Radio Blackouts - X-Ray Flares:

Low activity is expected throughout the forecast period with a chance of Moderate activity due to isolated M-class flares, mainly from the two complex regions in the southeast. but also due to AR3474 close to the southwest limb.

There are eight sunspot regions on the visible disc. AR3477 in the southeast quadrant is the largest region, but is a relatively simple Cho/Beta configuration. AR3480 closer to the southeast limb is more complex with a Dac/Beta-Gamma configuration, but as with AR3477 is relatively inactive. AR3474 on the southwest limb has become difficult to analyse but has a history of complexity and as such has the potential to produce M-class flares.

The remaining regions are either small or developing slowly.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	40	40	40
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at mainly background levels. The main source of any enhancement is likely to be from any filament eruptions or from any more significant flares. These are most likely to effect the Earth if originating from the western disc, with a slightly increased risk by the end of the period as the larger and more complex sunspots traverse into the hemisphere.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	2	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed at GOES16 has dropped to background levels due to the recent CME arrivals. A further arrival is likely to further suppress electron flux at GEO on 05 Nov as the belts are likely to be distorted, with the electrons displaced from their natural positions. After the CME effects ease, the electron flux is likely to slowly recover towards Moderate or High, but this is dependent on how quickly the geomagnetic activity eases. Further suppression is then possible due to the onset of the high speed stream from coronal hole 67.

Associated 24-hour electron flux, may decline below the Active threshold on 05 Nov. Further enhancements are subject to multiple factors such as a CME arrival and high speed stream connections and are currently considered to be low confidence.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	100	20	20	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1